Yoann Levis Launay

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Education

Ph.D in Applied Mathematics and Theoretical Physics *Oct 2022 – present*
DAMTP, University of Cambridge *Cambridge, United Kingdom*

Thesis title: *Non-linear General Relativity for Stochastic Inflation*

- Supervised by Prof. Paul Shellard, Dr. Gerasimos Rigopoulos (co-supervisor), Prof. Enrico Pajer (advisor).
- Minor in Data-intensive science (Center for Doctoral Training cohort), including courses in advanced scientific coding, machine learning, and statistics, as well as a 6 months placement in related industry.
- Expected date of graduation: September 2026.

Master of Advanced Studies in Physics (*Part III*) *Sept 2021 – June 2022*
University of Cambridge *Cambridge, United Kingdom*

Majors in Particle Physics, Relativistics Astrophysics and Cosmology, Quantum Field Theory.

- Obtained with Distinction, ranked 2nd as MASt.
- Minors in Advanced Statistical Mechanics, Gauge Field Theory, Quantum Information.
- MASt Thesis title: *Slow-roll oscillating non-Gaussianities from singular kinetic pre-inflationary universe*, supervised by Dr. Will Handley.

Master and Bachelor in General Engineering (*Grande école*) *Sept 2019 – June 2022*
CentraleSupélec, Paris-Saclay University *Paris, France*

Majors covering theoretical and engineering-oriented foundations in Mathematics, Physics, and Computer Science.

- Ranked top 5% out of 860 students.
- Minors in Relativistic Physics, Fluid Mechanics, High Performance Computing, Aeronautical and Space Physics, Energetic transition.
- Includes basics in Management, Economics, Law, Sociology, Philoshophy.
- Research track in Quantum Cristallography, supervised by Prof. Jean-Michel Gillet.
- Parallel Bachelor and Master 1 of Fundamental Physics (evening courses, highest honors, ranked 1st).
- Master's 2nd year awarded via MASt from University of Cambridge.

Preparatory Classes in Mathematics, Physics, Computer Science *Sept 2017 – July 2019*
Lycée Georges Clemenceau *Nantes, France*

Two-years intensive undergraduate course to prepare for the competitive national entrance exam to graduate engineering schools in France.

- Ranked 1/50 in first year.
- Secured national 2nd best engineering school in second year.
- Thesis: *Nash and optimal strategies in simplified traffic games.*

Experience

Ph.D Thesis *Oct 2022 – Oct 2026*
P. Shellard Research Group, DAMTP, University of Cambridge *Cambridge, United Kingdom*

Improving predictions for the early universe using stochastic inflation, supervised by Prof. P. Shellard and Dr. G. Rigopoulos.

- Generalized the theory of stochastic inflation beyond its simplest assumptions, embedding it consistently in full general relativity (GR).
- Derived initial conditions for numerical relativity simulations of inflation and evolved the first physical quantum inflationary perturbations in full GR, including pioneering GR dynamics of ultra-slow-roll and axion-monodromy models.
- Implemented the first stochastic Numerical Relativity code to simulate stochastic inflation.
- Provided new elements of validity for classical simulations to probe bispectra, via quantum field theory on curved spacetime using the Keldysh formalism.

Industry placement *Apr 2025 – Oct 2025*
Featuspace Inc. (Visa) Innovation Lab *Cambridge, United Kingdom*

Debiasing Vision-Language AI models to enhance fairness in classification tasks, supervised by Dr. P. Kamalaruban.

— Developed FairTPT, a novel fairness method using prompt tuning to jointly minimize performance while maximizing debiasing, without retraining a Vision-Language model and adapting during inference with a single input.

— Identified and mitigated catastrophic forgetting by monitoring loss dynamics, enabling stable and robust debiasing.

— Achieved state-of-the-art improvements in fairness across vision-language benchmarks while maintaining overall performance, establishing a framework for practical test-time fairness.

MASt Thesis *Jan 2022 – June 2022*
W. Handley Research Group, Cavendish Laboratory, University of Cambridge *Cambridge, United Kingdom*

Calculating non-Gaussian imprints from a kinetic type of pre-inflationary universe, supervised by Dr. W. Handley.

— Calculated slow-roll era contributions to the bispectrum using the In-In formalism for a range of initial conditions.

— Demonstrated the strong dependence of non-Gaussian signatures on the timing and nature of the transition between pre-inflation and inflation.

— Identified novel UV and IR divergences in the bispectrum, shown to be independent of vacuum choice.

Summer Research Internship *June 2021 – Sept 2021*
Irfu, CEA *Paris-Saclay, France*

Developed statistical methods to combine galaxy cluster counts and spatial correlations, aiming to improve constraints on cosmological parameters. Supervised by Dr. J.-B. Melin.

Undergraduate part-time research project *Sept 2019 – June 2021*
SPMS lab, CentraleSupélec *Paris-Saclay, France*

Modeling and inferring the full quantum state of electrons in crystals at non-zero temperatures. Supervised by Prof. J.-M. Gillet.

— Developed and implemented methods to reconstruct one-electron reduced density matrices (1-RDMs) from experimental X-ray structure factors and directional Compton profiles.

— Accounted for atomic thermal motion using simplified models that respect N-representability conditions while reproducing experimental observables.

— Applied Semi-Definite Programming techniques to derive static and temperature-dependent 1-RDMs, demonstrating robustness and high fidelity against experimental noise.

Preparatory Class Thesis *Sept 2018 – June 2019*
Lycée Georges Clemenceau *Nantes, France*

Finding Nash and optimal strategies in simplified traffic games.

— Studied Shapley Network Design games modeling travel between nodes with multiple paths and agents.

— Derived a theoreom giving the general Nash equilibrium for quadratic cost functions.

— Compared analytical equilibria to optimal network configurations obtained via genetic algorithms, quantifying efficiency gaps.

Research Interests

— Early universe cosmology
— Numerical relativity
— Classical and stochastic limit of Quantum Field Theory
— Bispectra
— Primordial Black Holes
— Primordial Gravitational Waves
— Simulation-Based Inference
— AI for Science

Publications

(preprint) Stochastic inflation in Numerical Relativity 2025
YL, G. Rigopoulos, P. Shellard arxiv:2512.14649

(preprint) Fairness-aware entropy for test-time adaptation 2025
YL, P. Kamalaruban, et al. (Featurespace) ICML 2026 submission

DMAP: A distribution map for text 2025
T. Kempton, et al. (Featurespace, **YL**) ICLR 2026

Bunch-Davies initial conditions and non-perturbative inflationary dynamics in Numerical Relativity 2025
Phys. Rev. D 112, 043518
YL, G. Rigopoulos, P. Shellard

Quantitative classicality in cosmological interactions during inflation 2024
JCAP05(2025)071
YL, G. Rigopoulos, P. Shellard

Stochastic Inflation in General Relativity 2024
Phys. Rev. D 109, 123523
YL, G. Rigopoulos, P. Shellard

N-Representable one-electron reduced density matrices reconstruction at non-zero temperatures 2021
Acta Cryst. B77, 683-694
YL, J.-M. Gillet

Awards and Scholarships

— (2025) DiRAC calendar featuring my simulations
— (2024) Smith-Knight/Rayleigh-Knight Prize laureate for best thesis preview essays
— (2023) G-research £1000 private grant for innovative research in quantitative fields
— (2022) 4 years International Fees Bursary (UKRI)
— (2022) 4 years Ph.D funding Department Award (DAMTP, KICC and CDT)
— (2022) Jennings prize for outstanding academic accomplishments
— (2021) CentraleSupélec Alumni prize for school community contribution
— (2020) Best poster prize (Quantum Crystallography Online Meeting conference)
— (2017) Scientific Baccalauréat with Highest Honors
— (2017) 7th/36 team prize at the National French Tournament of Young Mathematicians

Scientific Communications

— (Mar 2025) *The Dark Side of Stochastic Inflation*, Queen Mary University London seminar (**invited talk**).
— (Mar 2025) *Learning the emergence of cosmological patterns*, London Institute for Mathematical Sciences (**invited talk**).
— (Dec 2025) *Stochastic Inflation in Numerical Relativity*, Inflation 2025, Paris.
— (Sep 2025) *A stochastic spacetime for better inflationary predictions*, Cambridge–LMU Meeting, Munich.
— (July 2025) *Stochastic Inflation in Numerical Relativity*, International GR24-Amaldi16 conference, Glasgow.
— (July 2025) *When to use semi-classical GR instead of QFT to probe cosmological correlation functions: a quantitative view*, International GR24-Amaldi16 conference, Glasgow (**poster**).
— (June 2025) *Stochastic Inflation Beyond the Analytic Lamppost*, CoBALt conference, Paris (**invited talk**).
— (Feb 2025) *Vacuum, Quantum Diffusion & Non-Perturbativity of Inflaton Using Numerical Relativity*, Early Universe From Home, online.
— (June 2024) *Stochastic inflation in numerical relativity*, GRTL Collaboration Meeting, Cambridge.
— (May 2024) *Stochastic inflation in full general relativity*, UK Cosmology Meeting, King's College, Londo.n
— (Feb 2024) *Towards Reconciling Cosmology, QFT, and General Relativity Through Stochastic Inflation*, BritGrav24, Queen Mary University, London.
— (Feb 2024) *Towards Reconciling Cosmology, QFT, and General Relativity Through Stochastic Inflation*, GR Seminar at DAMTP, Cambridge (**invited talk**).
— (Dec 2023) *Stochastic Inflation in General and Numerical Relativity*, Cambridge–LMU Meeting, Munich.
— (Aug 2021) *N-representable 1-electron RDM at non-zero temperatures*, International Union of Cristallography congress, Prague.
— (Sep 2020) *N-representable 1-electron RDM at non-zero temperatures*, SPMS Laboratory seminar, CentraleSupélec, Paris (**invited talk**).
— (Aug 2020) *N-representable 1-electron RDM at non-zero temperatures*, 2020 Quantum Cristallography Online Meeting (**poster**).

Talks as contributing author:

— (Dec 2025) *Stochastic Inflation*, P. Shellard, The Hawking Legacy meeting: A scientific meeting and get-together, Albert Einstein Institute, Hannover (**invited talk**).
— (July 2025) *Stochastic Inflation in Numerical Relativity*, P. Shellard, Meeting on Numerical Simulation of Early Universe Sources of Gravitational Waves, Nordita, Stockholm.

— (July 2025) *Stochastic Inflation in General Relativity*, G. Rigopoulos, Meeting on Numerical Simulation of Early Universe Sources of Gravitational Waves, Nordita, Stockholm (**invited talk**).

— (April 2025) *Stochastic Inflation and Numerical Relativity*, P. Shellard, Meeting on Numerical Relativity and Fundamental Physics, ICTP Trieste (**invited talk**).

— (May 2024) *Stochastic Inflation in General Relativity*, Barcelona Black Holes (BBH) I: Primordial Black Holes conference, G. Rigopoulos, Barcelona (**invited talk**).

— (April 2024) *Stochastic Inflation and General Relativity*, P. Shellard, ITC Lunch seminar, Harvard-Smithsonian Center for Astrophysics, MIT, Cambridge, Massachusetts.

Teaching

— (2026) Demonstrator in *Field Theory in Cosmology* (Part III, University of Cambridge).

— (2024-present) Demonstrator in *Machine Learning* (Data-intensive Science MPhil, University of Cambridge).

— (2022-present) Supervisor in *General Relativity and Cosmology* (Undergraduate Tripos, Part II, University of Cambridge).

— (2022) Independent tutor for high school olympic Mathematics.

— (2016-18) Online tutor for high school Mathematics.

Responsibilities

— (2025-present) Treasurer and event convener of the Wolfson Science Society.

— (2024-present) Convener of the Non-Gaussianity group, DAMTP, University of Cambridge.

— (2024) Convener of the GRTL Collaboration Cambridge June Meeting.

— (2022-present) Writer/editor for *βluesci*, Cambridge University Science Magazine.

— (2020-21) Vice-President of the *Sustainable Engineers Forum Association* of CentraleSupéle.c

— (2020-21) Vice-President of the *Together 4 Earth Saclay* society.

Skills

— Programming: Python, C/C++, Mathematica, Matlab, Bash, Git, LaTeX.

— Data Science & Machine Learning: PyTorch, Pandas, NumPy, Scikit-learn.

— Numerical Relativity & Scientific Computing: GRChombo, GRTeclyn, MPI, OpenMP, FFTW, HDF5.

— Languages: French (native), English (fluent), German (intermediate).

Affilations

— Member of the *GRTL* and *UK Numerical Relativity* collaborations (software development).

— Member of the *Institute of Physics* (MInstP).

— Member of the *Cambridge Philosophical Society*.

References

— **Prof. Paul Shellard** (Ph.D supervisor), Director of the Hawking Center for Theoretical Cosmology, DAMTP, University of Cambridge, eps1@cam.ac.uk

— **Dr. Gerasimos Rigopoulos** (Ph.D co-supervisor), Senior Lecturer, Newcastle University, gerasimos.rigopoulos@newcastle.ac.uk

— **Dr. Parameswaran Kamalaruban** (Placement research supervisor), Senior Research Scientist, Featurespace (Visa), kaparame@visa.com

— **Dr. David Sutton** (Placement Manager), Chief Innovation Officer, Featurespace (Visa), dsutton@visa.com

— **Prof. Enrico Pajer** (Ph.D advisor), DAMTP, University of Cambridge, enrico.pajer@gmail.com

— **Dr. Will Handley** (MASt Thesis supervisor), Associate Professor, Cavendish Laboratory, University of Cambridge, wh260@cam.ac.uk

— **Dr. Jean-Baptiste Melin** (Internship supervisor), CEA, Paris-Saclay, jean-baptiste.melin@cea.fr

— **Prof. Jean-Michel Gillet** (Undergraduate research supervisor), CentraleSupélec, Paris-Saclay University, jean-michel.gillet@centralesupelec.fr